Modeling the transition from Hadron Gas to deconfined Quark Matter via the Albright-Kapusta-Young switch function.

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Abstract

In the present study, the transition from hadronic matter to deconfined quark matter is investigated using the switching function proposed by (Albright et al., 2014). This function has an exponential form, $S(\mu) = exp[-(\mu_0/\mu)^r]$, and enables a smooth interpolation between the two phases [1]. The analysis is performed at zero temperature (T = 0), thereby neglecting superconducting effects [2–5]. Under this assumption, the switching function reduces to the form introduced by (Blaschke et al., 2022) [2]. The adopted framework aims to describe a continuous transition from hadronic matter to deconfined quark matter, in contrast to the Maxwell and Gibbs constructions, which typically introduce discontinuities or sharp features in the pressure.

The hadronic equation of state (EoS) employed in modeling hybrid stars is based on the (Divaris et al., 2024) model [4], which depends on the parameter η and is constrained by nuclear matter properties such as the slope parameter L and the incompressibility parameter K_0. The quark matter EoS in the deconfined phase is taken from the model of (Blaschke et al., 2022) and is characterized by the parameters a_4, Δ, and B_{eff}. A set of ten hadronic EoSs is combined with a quark matter EoS, considering three distinct quark matter parameter sets. This approach allows for a systematic investigation of how the parameter η influences the hadronic EoS, while the parameters a_4, Δ, and B_{eff} govern the properties of the quark phase.

References

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